ROCKY FLATS PLANT, CRITICAL MASS LABORATORY
(Building 86) (Building 886)
Intersection of Central Ave. & 86 Dr.
Golden vicinity
Jefferson County
Colorado

HAER No. CO-83-A

HAER
COLO
30-GOLD.V
1A-

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
1849 C St. NW
Washington, DC 20240

HAER
COLO
30-GOLD.V,
1A-

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT,
CRITICAL MASS LABORATORY HAER No. CO-83-A
(Rocky Flats Plant, Building 886)

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 886 is in the southeast section of the industrial area of the Rocky Flats site, located at the intersection of Central Avenue and 86 Drive.

Date of Construction: 1964.

Fabricator: Stearns-Rogers Corporation, Denver, Colorado.

Present Owner: U.S. Department of Energy (USDOE).

Present Use: Inactive (experiments ceased in 1987).

Significance: This building is a primary contributor to the Rocky Flats Plant historic district, associated with the U.S. strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack on the U.S. This building was one of five critical mass laboratories in the nation that performed criticality measurements on a variety of fissile materials. The purpose of these experiments was to set safety standards for fissile material safety. These safety data have been used worldwide.

The Rocky Flats Plant (Plant) had unique site operations support organizations due to the handling of large amounts of radioactive materials. One such organization was the Nuclear Safety Group. The Plant's Critical Mass Laboratory conducted experiments directly tied to plant operations.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e²M), 1997. Alexandra Cole, Architectural Historian, Science Applications International Corporation, 1997.

Project Information:

In 1995, an inventory and evaluation of facilities at the Plant for their potential eligibility for listing in the National Register of Historic Places was conducted. The primary goal of this investigation was to determine the significance of the Cold War era facilities at the Plant in order to assess potential effects of the long-term goals and objectives of the USDOE. These goals and objectives have not yet been formalized, but include waste cleanup and demolition.

Recommendations regarding National Register of Historic Places eligibility were developed to allow USDOE to submit a formal determination of significance to the Colorado State Historic Preservation Officer for review and concurrence and to provide for management of historic properties at the Plant.

From this determination and negotiations with the Colorado State Historic Preservation Officer, the Advisory Council, and the National Park Service, and Historic American Engineering Record project began in 1997 to document the Plant's resources prior to their demolition. The archives for the Historic American Engineering Record project are located in the Library of Congress in Washington, D.C.

Introduction:

The Plant is one of thirteen USDOE facilities that constitute the Nuclear Weapons Complex, which designed, manufactured, tested, and maintained nuclear weapons for the United States arsenal. The Plant was established in 1951 to manufacture triggers for use in nuclear weapons and to purify plutonium recovered from retired weapons. The trigger consisted of a first-stage fission bomb that set off a second-stage fusion reaction in a hydrogen bomb. Parts were formed from plutonium, uranium, beryllium, stainless steel, and other materials.

The Plant was a top-secret weapons production plant, and employees worked with a recently man-made substance, plutonium, about which little was known concerning its chemistry, its interactions with other materials, and its shelf-life. The Historic American Engineering Record documentation effort focused on four aspects of the Plant and its role in the Nuclear Weapons Complex: manufacturing operations, research and development, health and safety of workers, and security.

Chronology of Building 886:

1963 Construction began.

1964 Construction completed.

1965 January 28 – technical readiness meeting held, permission to conduct criticality experiments granted.

1970s Office space added to northeast corner of building. Fissile metal storage room extended to southeast side of building to double storage space. Several programs for the Nuclear Regulatory Commission performed on a contract basis, in addition to supporting the plant mission.

1980 Office trailer was added to the northeast corner.

1987 October – last criticality experiment conducted.

1988 Plant curtailed production.

1992 Plant mission was changed to environmental restoration and waste management.

1997 Nuclear fuel removed from Building 886.

Building History:

The continued presence of large quantities of fissile material in numerous forms at the Rocky Flats Plant made it necessary to maintain an active criticality safety program. A Nuclear Safety Group was formed in 1953 to perform the criticality experiments. At that time, the group did not have its own facility. In those early years, the group performed subcritical experiments in the areas in which the materials were handled, using the actual materials which went into the production of the product. The experimenter would set up the production materials in various arrays to perform multiplication-type experiments ("in situ" experiments, which were always subcritical) and to measure critical nuclear conditions with respect to safe geometries for various kinds of production vessels, spacing parameters, shipping containers, and other items. Once Building 886 was commissioned, the Nuclear Safety Group conducted its work there. Since that time, the Nuclear Safety Group conducted about 1,700 critical mass experiments using uranium and plutonium in solutions (900 tests), compacted powder (300), and metallic forms (500).

Nuclear criticality safety can be defined as anything associated with avoiding an accidental nuclear criticality event. A criticality is an instantaneous nuclear fission chain reaction caused when too much fissile material is placed within too small an area. A criticality event would not result in a nuclear explosion, but could liberate a large amount of energy and high levels of radiation. While criticality events can vary widely in power level, the amount of radiation which could be generated in a criticality could be fatal to nearby personnel. Since the beginning of the nuclear industry to 1967, there have been a few dozen nuclear criticality accidents nation-wide. These extensively studied incidents, none of which occurred at Rocky Flats Plant, caused eight deaths and, in some cases, resulted in property damage (Rothe).

Building Description:

The Building 886 (originally called Building 86) complex consists of: Building 886 (Critical Mass Laboratory); Building 880 (storage facility); Building 875 (filter plenum facility); and an underground tunnel containing ventilation ducts that connects Building 886 to Building 875. Building 886 is rectangular with a shallow-pitched gabled roof. Two shed-roof wings extend from its northeast and southeast corners. A 37-foot tall concrete windowless building (Room 101) is attached to the south. A temporary pre-fabricated trailer housing offices is attached to the northeast wing by a breezeway. Building 886 is 10,360 square feet on a single level.

Building 886 consists of three areas: the Radiological Controlled Area; office space; and a small electronics and machine shop. The Radiological Controlled Area is comprised of three rooms and a hallway. Almost all criticality experiments were conducted in Room 101, the assembly room. The ceiling is 2 feet thick. Room 102, a storage vault, was constructed in the mid-1970s to meet the Department of Energy requirements for a Special Nuclear Material Vault. Both rooms, 101 and 102, have double reinforced concrete walls integrally case to the ceiling. Room 103, the Mixing Room, is a fissile solution storage area; three walls are reinforced concrete, and the west wall is cinder blocks. The remainder of the load bearing walls in Building 886 are constructed of cinder blocks.

Building Operations:

The primary mission of the Critical Mass Laboratory was to perform criticality measurements on a variety of fissile material configurations in support of plant activities. The criticality experiments and measurements were performed in order to establish criticality limits and ensure the safe handling and processing of fissile materials. A simplified sequence of events in performing a typical critical mass measurement involved removing the fissile material from storage, placing it in one of the Reactivity Addition Devices, operating the device remotely until criticality was achieved, measuring the slightly super critical parameters, reversing the operation of the device to slightly subcritical and measuring these parameters, completing the reversal to well below subcritical, and returning the fissile material to storage (Rothe). This effort supported the Plant's activities and assisted the Nuclear Regulatory Commission in setting of industry safety standards. The measurements were essential to validate computer models that were, in turn, used to establish nuclear criticality safety limits now called Criticality Safety Operating Limits.

The experiments were conducted in a manner to control the approach to criticality, for example, by varying the distance between pieces of metal and depth of solutions. Only rarely were the radiation levels such that it was not possible to directly touch the fissile material and testing apparatus immediately after the experiments. The experiments conducted in the Critical Mass Laboratory generally involved power levels generated of no more than 10 milliwatts for no more than one hour. Approximately half of the experiments conducted in Building 886 actually achieved criticality.

Highly enriched uranium was introduced into the building in the summer of 1965 and the first experiments were performed in September of 1965. Since then, the building was used to perform experiments on enriched uranium metal and solution, plutonium metal, low enriched uranium oxide, and several special applications. After 1983, experiments were conducted primarily with uranyl nitrate solutions, and did not involve solid materials.

Experiments to validate the safety parameters for the storage of fissionable solutions in Raschig Ring tanks resulted in the design of two-substitute storage tank configurations: the Annular tank and the Poison Tube tank (Rothe). These designs allowed for more economical solution testing

with no decrease in safety. The Poison Tube tanks were not used at the Plant due to the change in the overall site mission; however, they have been used at other USDOE facilities. Experiments were also conducted to validate the cross-sections and usefulness of materials (i.e., concrete, polyvinyl chloride) used at the Plant. Data generated from decades of experiments at the Plant is still being used to set new safety standards and validate computer models.

Sources: Rothe, Dr. Robert E., nuclear criticality experimenter in nuclear safety employed at the Plant since August 1964. Personal communication, 1997.

United States Department of Energy, Public Affairs. n.d. *Tour Information. Rocky Flats Facilities.* U.S. Department of Energy, Office of Communications and Economic Development. Rocky Flats Repository. Golden, Colorado.

United States Department of Energy. *Mission Transition Program Management Plan, Site Support Facilities Element. Appendix A-1, A-2, A-3, A-5 Revision 7, A-4 Revision 4 (1992),* by EG&G. Rocky Flats Plant Repository, Golden, Colorado, 1992.

United States Department of Energy. *Reconstruction of Historical Rocky Flats Operations and Identification of Release Points: Final Draft Report (1992),* by ChemRisk. Rocky Flats Repository. Golden, Colorado, 1992.

United States Department of Energy. *Basis for Interim Operations, Building 886, Revision A (Daft) (1995)*, by EG&G. Rocky Flats Repository. Golden, Colorado, 1995.

United States Department of Energy. *Final Cultural Resources Survey Report, Rocky Flats Environmental Technology Site, The Industrial Area,* Rocky Flats Repository. Golden, Colorado, 1995.